



## BACKGROUND NOTE

## Artificial Intelligence and HBS

**artificial intelligence** [*mass noun*] – The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.

– (English Oxford Living Dictionary)

"[A]s digital technology transforms process after process, it is not just displacing human activity, it is changing the most essential properties of work, with vast implications for the nature of firms, how they operate, and how they interact with the rest of the economy."<sup>1</sup>

### Introduction

Over the past twenty years, the twin forces of internet-driven connectivity and the rapid digitization of work-related activities have impacted most every sector of the global economy.<sup>2</sup> The effects on companies have been profound, with 60% of the companies in the S&P 500 in 1998 no longer present in the 2018 listings. Today, six of the top ten firms by market capitalization have harnessed these forces as core elements of their business model as opposed to just one in the prior decade.

A derivative effect of this enterprise transformation has been the creation of vast troves of data that are being harnessed through artificial intelligence (AI) technologies. All six of the top ten firms in the S&P 500 have become leaders in AI, with many of them pursuing an “AI-first” strategy.

Although more than 80% of executives believe AI will give their organization a competitive advantage, only 20% of companies have adopted AI in some capacity.<sup>3</sup> There are multiple barriers that might prevent a firm from adopting AI, such as inadequate IT infrastructure, insufficient/bad data, or lack of expertise. Additionally, effective management and implementation of AI are crucial.

The demand for training of new data/AI scientists is being answered by top computer science and engineering schools like MIT, CalTech, and Stanford. While graduates of these programs are fluent in

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<sup>1</sup> Marco Iansiti and Karim R. Lakhani, *Competing in the Age of AI*, Harvard Business Review Press, forthcoming.

<sup>2</sup> Marco Iansiti and Karim R. Lakhani, “Digital Ubiquity: How Connections, Sensors, and Data Are Revolutionizing Business.” *Harvard Business Review* 92, no. 11 (November 2014): 90-99.

<sup>3</sup> S. Ransbotham, D. Kiron, P. Gerbert, and M. Reeves, “Reshaping Business With Artificial Intelligence,” MIT Sloan Management Review and The Boston Consulting Group, September 2017.

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This note was prepared for the Board of Dean's Advisors meeting.

the language of data, they don't necessarily speak the language of business. It is this gap, between the data scientist and the CEO, where HBS can train the next generation of executives and managers to be fluent in both business and data science, and to act as the translational catalyst that will drive the adoption and application of AI in firms. We will also need to educate these leaders to use AI wisely and ethically, in ways that leverage its tremendous possibilities while avoiding its many dangers.

## HBS and AI

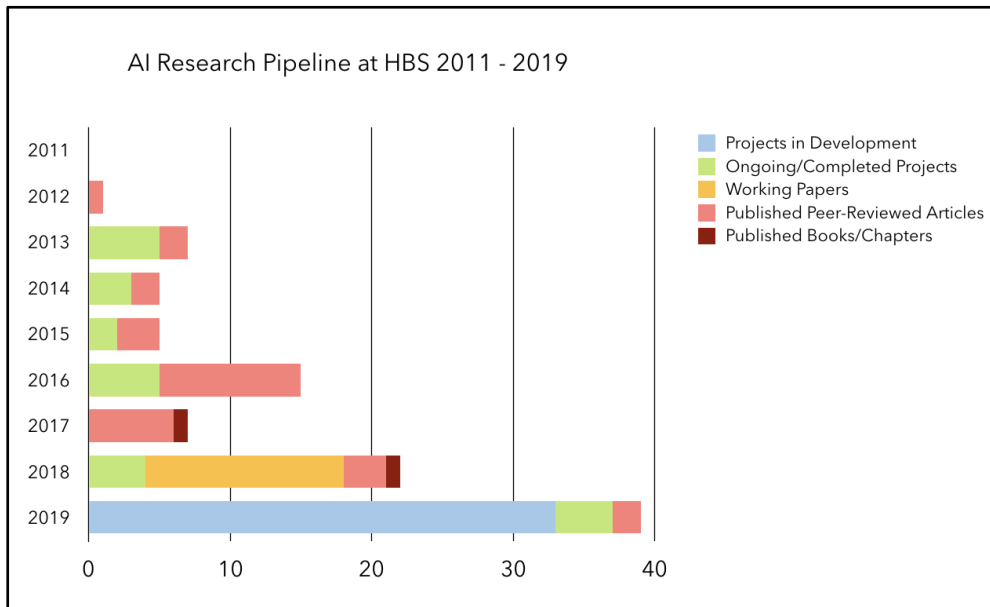
To date, HBS faculty members have built a strong foundation of AI-related research and course development: nearly 60 faculty members have written a case, conducted a field experiment, or published a journal article in this area. With 20% of new faculty members hired over the last five years indicating interest in this arena, activity would only increase. The largest concentration of these faculty members is in the Technology and Operations Management and Marketing units.

### *Research*

Research is the engine that drives both course development and the dissemination of ideas that influence management practice. To date, 46 faculty members have conducted AI-related research spread roughly equally across three areas:

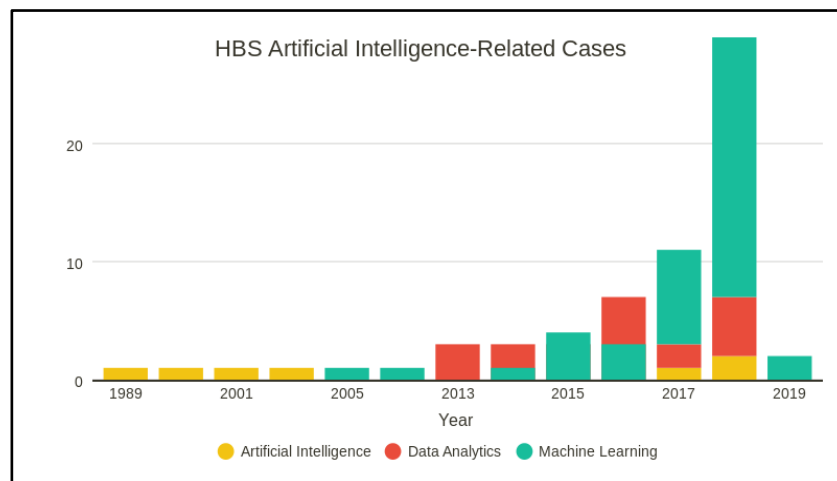
1. Studying the effects of AI on a firm. For example, a 2018 case by Lauren Cohen and Christopher Malloy, "Artificial Intelligence and the Machine Learning Revolution in Finance: Cogent Labs and the Google Cloud Platform," explores how case protagonist David Malkin (Cogent's AI Architect) can position his firm for growth in a context where AI had the potential to revolutionize several aspects of the financial services industry.
2. Applying existing machine learning techniques to draw inferences that previously weren't available with traditional methods. For example, a recent case by Srikant Datar looks at a recent MBA graduate evaluating LendingClub, a peer-to-peer lending model to connect borrowers to investors, as a potential investment vehicle for the small wealth management firm she will join. Using LendingClub's data and risk evaluation model, as well as predictive analytics, she tries to build models to predict whether borrowers will repay or default on their obligation. Similarly, Mike Toffel's case, "Improving Worker Safety in the Era of Machine Learning," examines OSHA's efforts to select a predictive algorithm so as to improve how it targets its government inspections of workplaces to better assure safe working conditions.
3. Creating new machine learning approaches and algorithms. For example, researchers at the Laboratory for Innovation Science at Harvard (LISH) have completed projects that include developing new algorithms to improve the accuracy and speed of computational processes for NASA and the Broad Institute; natural language processing techniques to analyze the comparative data collected from over 1,600 oral histories and memories of the 1947 Partition of British India to determine trends and patterns in attitudes and belief; and a computer vision algorithm using two months of live data from a European automotive company to detect abnormal system behavior more reliably than a commonly-used outlier detection technique.

There are 33 AI projects—almost entirely focused on machine learning—in the pipeline for 2019-2020 from 26 faculty members.



Case Development

To date, 71 AI-related cases have been published by HBS faculty members.



The increase in case writing and the emergence of AI-related cases at HBS in the 2010s corresponds to the big data movement that emerged during this time and gained traction with the adoption of data analytics in 2012.<sup>4</sup> As data became more accessible, computational power more cost effective, and algorithms more advanced, so too did the advancement of the application of data.<sup>5</sup>

<sup>4</sup> Andrew McAfee and Eric Brynjolfsson, “Big Data: The Data Revolution: Big Data, Open Data, Data Infrastructures and Their Consequences.” *Harvard Business Review* (October 2012), 67–79.

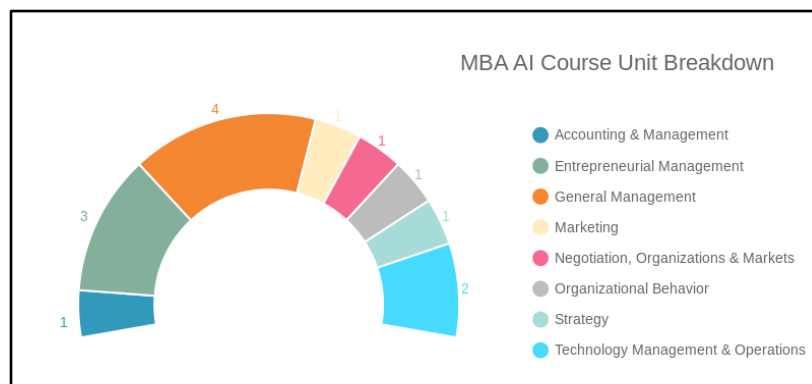
<sup>5</sup> Benaich, N., & Hogarth, I. (2018). *The State of Artificial Intelligence in 2018: A Good Old Fashioned Report*(Rep.). Retrieved January 15, 2019, from <https://www.stateof.ai/>

In recent years faculty members have begun pursuing cases encompassing data analytics, machine learning and AI applications in a wide array of industries—including business and professional services, consumer services, financial services, government, healthcare, media/leisure/entertainment, retail, and transportation—which parallels the real-world propagation of AI in these industries. These cases demonstrate the growing number of use cases for these technologies—from improving targeting of customers, to providing them machine assisted service, to making supply chains more effective, to assisting experts in decision-making, to developing completely new products and services. **Appendix 1** provides a listing of these cases, with a short description, and tags that identify topics covered.

## Educational Programs

### MBA Program

During 2018-2019, 14% of courses in the Elective Curriculum include AI-related content. The variation across courses is high, as a course such as *Managing with Data Science* give students the opportunity to go deep in familiarizing themselves with the fundamentals of data science and apply their knowledge directly, while a course like *Scaling Technology Ventures* exposes students to a variety of startups of which AI may be a product offering of only one.



Other courses that feature AI-related cases in a material manner include:

**Managing with Data Science** (Srikant Datar) – Familiarize students with the fundamentals of data science such that they can work effectively with a data science team in an organization, both to shape the ask and interpret outputs; develop their understanding of data science's implications for management and decision making in a data-rich environment.

**Managing the Future of Work** (Bill Kerr) – How the workforce is likely to evolve in advanced and emerging economies; factors that will influence the future of work, including the impact of AI and related technologies.

**Launching Technology Ventures** (Jeff Busgang, Sam Clemens) – Technology-based ventures in the Internet, mobile, and enterprise software sectors, several of which are now using AI. Business models range from subscription to SAAS to freemium to developer-driven.

**Scaling Technology Ventures** (Jeffrey Rayport) – Designed for students who plan to join rapidly growing technology ventures, who are preparing to scale their own technology ventures, or who plan to evaluate such ventures through the lens of principal investing, with a particular emphasis on scaling new ventures in the Internet, mobile, and enterprise software sectors.

**CS50 for MBAs: Computer Science for Business Leaders** (David Malan/SEAS) - A variant of Harvard College's introduction to computer science designed especially for MBA students; emphasizes mastery of high-level concepts and design decisions related thereto.

**Entrepreneurship and Technology Innovations in Education** (John J-H Kim) - Explores how entrepreneurs are applying business practices and technology innovations to transform classrooms and schools/colleges to drive higher performance.

**Immersive Field Course: Los Angeles; Hollywood: Distribution and Marketing Challenges in a Digital World** (Henry McGee) - Driven by the twin forces of digitalization and globalization, the industry is undergoing rapid and unprecedented change; students undertake consulting projects with both existing players and disruptors.

**Public Entrepreneurship** (Mitch Weiss) - Designed for students who may found, join, or fund private startup companies that sell to (or around) governments to solve giant problems or who may want to become extreme innovators inside government at some point themselves; may be of particular interest to students curious about AI, autonomy, blockchain, sensors, crowdsourcing, platforms, and related topics, as the cases feature a broad range of contemporary technology applications.

**Reigniting Value through Frontier Technologies (IoT/ML/AI/AR/VR/Blockchain)** (Rajiv Lal) - Focuses on developing an understanding of the impact of a series of frontier technologies (Internet of Things, Artificial Intelligence, Virtual Reality, Autonomous Vehicles, Machine Learning, Augmented Reality, and Blockchain) on your business.

**From Data to Decisions: The Role of Experiments** (Michael Luca) - Helps students develop an experimental mindset, and an appreciation of how experiments within organizations can be used to improve managerial decision-making. This course will help to familiarize students with the fundamentals of randomized controlled trials, allowing them to get the most from experimental insights and to work effectively in an increasingly data-driven world.

**People Analytics: Leading in a Data-Driven World** (Jeff Polzer) - Designed to help students use data and manage others who use data to improve people-related decisions and practices in their role as a general manager. Students in most jobs, organizations, and industries will need enough data fluency to be a competent consumer of analyses of employee data, which is rapidly becoming part of the analytics revolution. The best way to achieve this goal is to build hands-on skills by analyzing and interpreting data in ways that complement the frameworks and intuitions that normally guide managerial actions.

**Strategy and Technology** (David Yoffie) - Explores the unique aspects of creating effective management and investment strategies for technology-intensive businesses. What are effective strategies for winning in markets with strong network effects? How can technology be leveraged to build multi-sided platforms? How can firms create and capture the value from intellectual property assets? What are the unique challenges of governing technology-intensive firms? And how can they build and sustain value in new, emerging technologies with high degrees of uncertainty?

**Digital Innovation and Transformation** (Shane Greenstein) - Equips students to confidently help conceive, lead and execute digital innovation initiatives and develop new business models for existing and insurgent organizations. The basic premise of the course is that the digital revolution is rapidly transforming the fundamental nature of many companies in a wide range of industries and executives, entrepreneurs and general managers need to understand the economics, technology paradigms and management practices of innovating in digital-centric businesses to ensure corporate and personal success.

**Field Course: Lab to Market** (Karim R. Lakhani, Peter Barrett, Noubar Afeyan, Eva Guinan/HMS) – Designed to outline the path from embryonic discoveries made in R&D labs to their development for commercial use and onwards to market launch; for students who either want to start businesses that have science and technology intellectual property at their core or anticipate leading market launch teams in incumbent organizations.

Additionally, in January 2019, Professors Marco Iansiti and Karim Lakhani offered a Short Intensive Program on the Business of AI. More than twice as many students than could be enrolled expressed interest in the four-day course. Ultimately, 75 first- and second-year students engaged with HBS faculty as well as with faculty from the Harvard John A. Paulson School for Engineering and Applied Sciences (SEAS), industry leaders, and Harvard alumni in venture capital, financial services, robotics, and ecommerce.

#### *Executive Education*

HBS offers four focused programs with AI-related pedagogy:

**Competing on Business Analytics and Big Data** (John Deighton, Karim Lakhani) – Companies across the globe are collecting huge volumes of data about their customers, operations, and performance—but data alone won't deliver competitive advantage. This big data analytics program explores the strategic opportunities presented by the explosion in data, and enables you to harness the power of big data to transform your company. Participants acquire a firm grounding in data analytics and practical strategies for implementing data-focused initiatives that create and capture more value.

**Driving Digital Strategy** (Sunil Gupta) – Across every industry, digital technologies are redefining the way consumers engage and companies compete. This challenging digital business strategy course provides the comprehensive framework for mastering digital leadership and organizational transformation. Participants explore the latest technologies and learn how to leverage digital, social, and mobile marketing tools to drive innovation and spur growth.

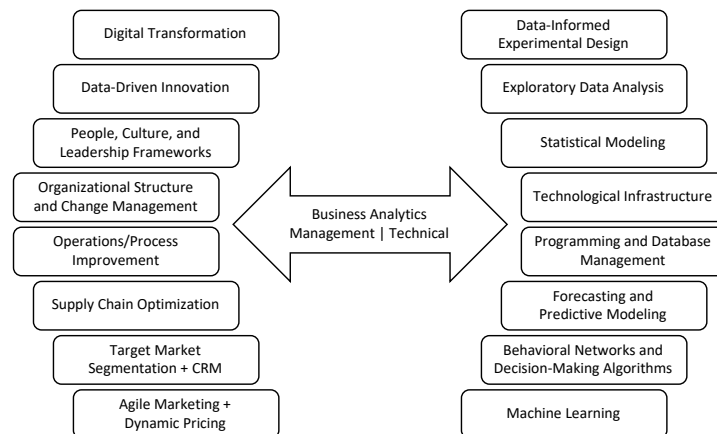
**Leveraging Fintech Innovation to Grow and Compete** (Marco Di Maggio, Luis Viceira) – Blockchain, machine learning, big data, artificial intelligence, and other innovations in fintech are revolutionizing the finance industry—and creating new challenges for both startups and incumbent firms that are competing for market share. To succeed in this environment, startups have to build, fund, and grow an innovative operation that can outperform larger companies, while incumbent firms have to rethink their offerings and digital capabilities to safeguard against disruption. Participants explore best practices for managing these issues, consider the latest breakthroughs in fintech, and establish a game plan for their company – whether you're driving or defending against disruption.

**Leading an Agile Workforce Transformation** (Joe Fuller, Bill Kerr) – Corporate leaders and senior decision-makers must seize the opportunities presented by rapid technological advances, shifting demographics, and new employment models to ensure today's businesses endure in the future. To build and maintain competitive advantage, businesses must recognize and manage the risks, while also capitalizing on the changing nature of work, workplace organization, and the workforce itself. This program will help participants make the right moves today to develop and sustain the agile workforce they will need tomorrow.

Plans are underway to create a modular offering in the long Comprehensive Leadership Programs (AMP, GMP, PLD, OPM), with a prototype being tested in AMP starting in Spring 2019.

HBS also has led the development of the Harvard Business Analytics Program (HBAP). Launched in March 2018 with faculty from HBS, SEAS, and the Faculty of Arts and Sciences (FAS), HBAP is a nine-month program for executives that combines asynchronous digital content, live online classes,

intensive tutorial sessions, and two short on-campus immersions to (re-train) a generation of business leaders that understand both the technical foundations of AI and their applications to business and organizations. More than 70 participants have completed the program to-date and another 400 are enrolled. Participants have 15+ years of experience and two-thirds have advanced degrees; many see this education as catalytic for their next phase in their careers.



### *Initiatives*

In addition to the work of individual faculty members, there are three cross-disciplinary AI-related efforts at HBS.

**Digital Initiative (HDI)** – Since 2017 the Digital Initiative has been building a community and expertise around the digital transformation of the economy at HBS and beyond through curated content, facilitated exchange, and thought leadership. In addition to organizing events like the Digital Transformation Summit and Future Assembly, HDI creates original content for practitioners. To date, HDI has published 17 articles on AI and machine-learning; it engages 24 active and 15 affiliated faculty members.

**Laboratory for Innovation Science at Harvard (LISH)** – Led by Karim Lakhani (HBS), Eva Guinan (Harvard Medical School), and David Parkes (SEAS), the Laboratory for Innovation Science at Harvard is spurring the science of innovation through a systematic program of solving real-world innovation challenges while simultaneously conducting rigorous scientific research analysis. With 20 researchers and managers, LISH currently employs four of the six data scientists at HBS and is uniquely positioned to take on complex AI-related research questions. HBS faculty involved with LISH span four units (Accounting and Management, Entrepreneurial Management, Technology and Operations Management, and Strategy) and include Dennis Campbell, Chiara Farronato, Kris Ferreria, Marco Iansiti, Tarun Khanna, Rem Koning, Rafaella Sadun, and Chris Stanton. In addition to empirical research, LISH collaborates with faculty on the development of practitioner-related resources, such as the development and management of the LISH Innovation Science Guide, an online repository of working papers, white papers, presentations and videos related to AI.

**Managing the Future of Work** – The Managing the Future of Work project pursues research that business and policy leaders can put into action to navigate the forces that are redefining the nature of work, including technology trends like artificial intelligence. Several episodes of the "Managing the Future of Work" podcast, hosted by faculty co-chairs Bill Kerr and Joe Fuller, provide insight into the ways that artificial intelligence will transform industries and their workforce through interviews with business leaders, experts, and HBS faculty.

## *Convening and Dissemination*

### *Harvard Business Review*

Harvard Business Review connects leaders in academia and industry. Beginning in 2014 the prevalence of AI-related articles has grown sharply, with a 50% increase in 2015 to 2016 alone.

Additionally, the online HBR community is active in pursuing AI-related content. In October 2018, HBR launched an eight-issue data science newsletter, and as of 3/1/19, it had 38K subscribers. To date, HBR has mailed out 270K newsletters.

### *Events*

There has been growing interest across the HBS community in AI-related events. Since 2017, there have been 19 events related to AI, including research presentations, student-organized industry talks, and convenings with industry leaders to explore the effect of AI on their firms. Notable events are Future Assembly and the Digital Transformation Summit, both organized annually by the HBS Digital Initiative, which provide a setting where academics and practitioners can examine the challenges and opportunities of tomorrow's technology. In addition, the Harvard Data Science Initiative, led by SEAS Professor David Parkes, has held multiple events on the HBS campus (see **Appendix 2** for 2018-2019 activities).

### *MBA Student Groups*

Two student groups at HBS organize AI-related events, the Business Analytics & (big) Data Club and the Tech Club.

## **Reflections**

The School had largely taken a decentralized approach—relying upon the interests and initiative of individual faculty members—to incorporating the role of AI in its research and educational activities. The results had been encouraging, with the number of faculty members and the range of AI related intellectual projects they were pursuing growing rapidly. MBA Chair Jan Rivkin had recently made educating leaders who can use data for judgment, and judgment for data, as one of the program's three key pedagogical priorities. Was that goal best pursued by continuing this bottom-up approach? Several peer universities, such as MIT and Stanford, had launched large-scale inter-disciplinary initiatives to study AI. Should HBS take the lead in catalyzing such a One Harvard initiative, or simply pursue its own agenda?



## Appendix 1 Cases, 2010-2018

Simons, Robert, and Natalie Kindred. "Agero: Enhancing Capabilities for Customers." HBS Case 113-001, 2013.  
Tags: Strategy, Organizational Change, Data Analytics, Change Customer Engagement

Davenport, Thomas H., Marco Iansiti, and Alain Serels. "Managing with Analytics at Procter & Gamble." HBS Case 613-045, 2013.  
Tags: Data Analytics, Retail, Sales, Enterprise, Publicly Traded

Lakhani, Karim R., Marco Iansiti, and Kerry Herman. "GE and the Industrial Internet." HBS Case 614-032, 2014.  
Tags: Data Analytics, Information Technology, Enterprise, Strategy, Sales, Publicly Traded

Bernstein, Ethan, Saravanan Kesavan, Bradley Staats, and Luke Hassall. "Belk: Towards Exceptional Scheduling." HBS Case 415-023, 2014.  
Tags: Machine Learning, Organizational Change, Supply Chain and Operations, Retail, Information Technology

Simons, Robert, and Natalie Kindred. "Quiet Logistics (A)." HBS Case 115-001, 2014.  
Tags: Data Analytics, Startup, Retail, Supply Chain and Operations, Organizational Change, Reduce Operational Costs

Quelch, John A., and Margaret L. Rodriguez. "Carolinas HealthCare System: Consumer Analytics." HBS Case 515-060, 2015.  
Tags: Healthcare, Data Analytics, Information Technology, Change Customer Engagement

Deighton, John, and Leora Kornfeld. "Instacart and the New Wave of Grocery Startups." HBS Case 515-089, 2015.  
Tags: Machine Learning, Retail, Sales, Startup, Future of Work, Consumer Services, Change Customer Engagement, Rapid Innovation

Applegate, Lynda M., Karim R. Lakhani, and Nicole Bucala. "Podium Data: Harnessing the Power of Big Data Analytics." HBS Case 816-007, 2015.  
Tags: Data Analytics, Information Technology, Organizational Change

Kanter, Rosabeth Moss, and Daniel Fox. "Bridj and the Business of Urban Mobility (A): Developing a New Model." HBS Case 316-025, 2015.  
**Tags:** Startup, Transportation, Data Analytics, Government, Reduce Operational Costs

Applegate, Lynda M., Gabriele Piccoli, and Federico Pigni. "Duetto: Industry Transformation with Big Data." HBS Case 816-028, 2015.  
Tags: Travel and Logistics, Information Technology, Organizational Change

Shih, Willy C. "Building Watson: Not So Elementary, My Dear! (Abridged)." HBS Case 616-025, 2015.  
Tags: Machine Learning, Information Technology, Product Innovation and R&D, Enterprise, Publicly Traded, Data Science

Lakhani, Karim R., Marco Iansiti, and Christine Snively. "Aspiring Minds." HBS Case 616-013, 2015.  
Tags: Machine Learning, Startup, Future of Work, Information Technology, Education, Strategy, Asia, Reduce Operational Costs

Bell, David E., Forest Reinhardt, and Mary Shelman. "The Climate Corporation." HBS Case 516-060, 2016.  
Tags: Startup, Data Analytics, Manufacturing and Production, Marketing, Information Technology, Adoption

Kanter, Rosabeth Moss, and Jonathan Cohen. "Whither the Weather (Company): Forecasting 2016." HBS Case 316-143, 2016.  
Tags: Data Analytics, Organizational Change, Media Leisure, Entertainment, Enterprise, Publicly Traded

Beshears, John. "Evide Health and Workplace Influenza Vaccinations." HBS Case 916-044, 2016.

Tags: Healthcare, Data Analytics, Change Customer Engagement

Zhu, Feng, and Angela Acocella. "Fasten: Challenging Uber and Lyft with a New Business Model." HBS Case 616-062, 2016.

Tags: Startup, Future of Work, Information Technology, Transportation, Marketing

Deighton, John A., and Leora Kornfeld. "Legendary Entertainment: Moneyball for Motion Pictures." HBS Case 516-117, 2016.

Tags: Machine Learning, Media Leisure, Entertainment, Marketing

Shih, Willy. "Building the Digital Manufacturing Enterprise of the Future at Siemens." HBS Case 616-060, 2016.

Tags: Information Technology, Organizational Change, Manufacturing and Production, Data Analytics, Europe

Yoffie, David B., Liz Kind, and David Ben Shimol. "Numenta: Inventing and (or) Commercializing AI." HBS Case 716-469, 2016.

Tags: Machine Learning, Startup, Healthcare, Machine Learning

Lal, Rajiv, and Sarah McAra. "Spectio: A Digital Lighting Company." HBS Case 517-002, 2016.

Tags: Energy, Information Technology, Data Analytics, Adoption, Sales, Marketing, Startup

Cespedes, Frank V., John Deighton, Lisa Cox, and Olivia Hull. "DataXu: Selling Ad Tech." HBS Case 817-012, 2016.

Tags: Marketing, Data Analytics, Sales, Organizational Change

Campbell, Dennis, and Gamze Yucaoglu. "Turkasset: Bringing Customer-Centricity to Debt Collection." HBS Case 117-023, 2016.

Tags: Data Analytics, Financial Services, Organizational Change, Information Technology, Middle East

Kanter, Rosabeth Moss, and Jonathan Cohen. "IBM Transforming, 2012–2016: Ginni Rometty Steers Watson." HBS Case 317-046, 2017.

Tags: Machine Learning, Organizational Change, Startup, Enterprise, Strategy, Information Technology

Kerr, William R., Gamze Yucaoglu, and Eren Kuzucu. "Yemeksepeti: Growing and Expanding the Business Model through Data." HBS Case 817-095, 2017.

Tags: Consumer Services, Startup, Data Analytics, Asia, Rapid Innovation

Choudhury, Prithwiraj, Tarun Khanna, and Sarah Mehta. "The Future of Patent Examination at the USPTO." HBS Case 617-027, 2017.

Tags: Government, Organizational Change, Machine Learning, Intellectual Property, Reduce Operational Costs

Israeli, Ayelet, and Jill Avery. "Predicting Consumer Tastes with Big Data at Gap." HBS Case 517-115, 2017.

Tags: Retail, Sales, Enterprise, Data Analytics, Machine Learning, Publicly Traded, Deliver strategic insights currently not available to business decision makers

Bartlett, Christopher A., Rachel Gordon, and John J. Lafkas. "RoboTech: Storming into the U.S. Market." HBS Brief Case 918-501, 2017.

Tags: Startup, Healthcare, Information Technology, Strategy

Datar, Srikant M., and Caitlin N. Bowler. "Tamarin App: Natural Language Processing." HBS Case 118-015, 2017.

Tags: Startup, Machine Learning, Natural Language Processing, Information Technology, Deliver strategic insights currently not available to business decision makers

Bernstein, Ethan, Paul McKinnon, and Paul Yarabe. "GROW: Using Artificial Intelligence to Screen Human Intelligence." HBS Case 418-020, 2017.

Tags: Startup, Future of Work, Information Technology, Machine Learning, Asia, Automate knowledge work/reduce the need for more costly human resources

Datar, Srikant M., and Caitlin N. Bowler. "Data Science at Target." HBS Case 118-016, 2017.

Tags: Machine Learning, Retail, Sales, Enterprise, Change Customer Engagement

Toffel, Michael W., Dan Levy, Jose Ramon Morales Arilla, and Matthew S. Johnson. "Improving Worker Safety in the Era of Machine Learning (A)." HBS Case 618-019, 2017.

Tags: Data Science, Healthcare, Government, Supply Chain and Operations, Machine Learning, Organizational Change

Kontokosta, Constantine E., Mitchell Weiss, Christine Snively, and Sarah Gulick. "NYC311." HBS Case 818-056, 2017.

Tags: Government, Information Technology, Machine Learning, Ethics, Reduce Operational Costs

Avery, Jill, and Thomas Steenburgh. "HubSpot and Motion AI: Chatbot-Enabled CRM." HBS Case 518-067, 2018.

Tags: Marketing, Information Technology, Natural Language Processing, Machine Learning, Customer Service, Change Customer Engagement

Greenstein, Shane, and Christine Snively. "Viacom: Democratization of Data Science." HBS Case 618-016, 2018.

Tags: Data Analytics, Data Science, Media Leisure, Entertainment, Organizational Change, Strategy, Develop new strategic insights currently not available to business decisions makers

Kerr, William, Allison Ciechanover, Jeff Huizinga, and James Palano. "Autonomous Vehicles: The Rubber Hits the Road...but When?" HBS Case 818-088, 2018.

Tags: Machine Learning, Economy, Adoption, Deep Learning, Computer Vision, Transportation, Automation

Cohen, Lauren, Christopher Malloy, and William Powley. "Artificial Intelligence and the Machine Learning Revolution in Finance: Cogent Labs and the Google Cloud Platform (GCP)." HBS Case 218-080, 2018.

Tags: Machine Learning, Financial Services, Information Technology, Organizational Change, Asia

Luo, Hong, Esther Yan, and Taro Tan. "General Motors and Autonomous Vehicle Regulation." HBS Case 718-496, 2018.

Tags: Government, Machine Learning, Computer Vision, Transportation, Policy

Ofek, Elie, Tian Tao, Eden Yin, and Nancy Hua Dai. "Huawei: How Can We Lead the Way?" HBS Case 518-071, 2018.

Tags: Machine Learning, Information Technology, Hardware, Retail, Sales, Marketing, Strategy, Asia

Lal, Rajiv, and Scott Johnson. "Amazon, Google, and Apple: Smart Speakers and the Battle for the Connected Home." HBS Case 518-035, 2018.

Tags: Information Technology, Hardware, Strategy, Enterprise, Retail

Wang, Charles C.Y., and Kyle Thomas. "New Constructs: Disrupting Fundamental Analysis with Robo-Analysts." HBS Case 118-068, 2018.

Tags: Machine Learning, Financial Services, Finance, Automation

Kerr, William R., and Emer Moloney. "Vodafone: Managing Advanced Technologies and Artificial Intelligence." HBS Case 318-109, 2018.

Tags: Machine Learning, Organizational Change, Information Technology, Retail, Enterprise, Publicly Traded, Europe, Reduce Operational Costs

Lal, Rajiv, and Scott Johnson. "IBM: Watson and the Internet of Things." HBS Case 518-027, 2018.  
Tags: Machine Learning, Organizational Change, Strategy, Enterprise, Publicly Traded, Information Technology

Groysberg, Boris, and Katherine Connolly Baden. "TrustSphere: Building a Market for Relationship Analytics." HBS Case 418-070, 2018.  
Tags: Data Analytics, Information Technology, Customer Services, Asia, Change Customer Engagement

Cowgill, Bo, and Rembrand Koning. "Matching Markets for Googlers." HBS Case 718-487, 2018.  
Tags: Information Technology, Enterprise, Organizational Change, Future of Work, Deliver strategic insights currently not available to business decision makers

Zhu, Feng, and Shirley Sun. "JD: Envisioning the Future of Retail." HBS Case 618-051, 2018.  
Tags: Retail, Consumer Services, Machine Learning, Supply Chain and Operations, Asia

Groysberg, Boris, Sarah Abbott, and Annelena Lobb. "Cowen Inc.: Leveraging Data." HBS Case 418-035, 2018.  
Tags: Financial Services, Finance, Startup, Data Analytics, Strategy, Publicly Traded

George, William W., and Amram Migdal. "Facebook Confronts a Crisis of Trust." HBS Case 318-145, 2018.  
Tags: Information Technology, Government, Ethics, Security and Risk, Europe

Avery, Jill, and Ayelet Israeli. "Hubble Contact Lenses: Data Driven Direct-to-Consumer Marketing." HBS Case 519-011, 2018.  
Tags: Startup, Healthcare, Marketing, Data Analytics

Santana, Shelle M., and Esel Çekin. "Garanti Payment Systems: Digital Transformation Strategy (A)." HBS Case 519-014, 2018.  
Tags: Financial Services, Information Technology, Middle East

Avery, Jill. "Tailor Brands: Artificial Intelligence-Driven Branding." HBS Case 519-017, 2018.  
Tags: Startup, Marketing, Machine Learning, Business and Professional Services, Middle East, Automate knowledge work/reduce the need for more costly human resources

Datar, Srikant M., and Caitlin N. Bowler. "LendingClub (A): Data Analytic Thinking (Abridged)." HBS Case 119-020, 2018.  
Tags: Startup, Financial Services, Data Analytics, Data Science, Machine Learning, Automation

Simons, Robert, and George Gonzalez. "C3: Driven to Succeed." HBS Case 119-004, 2018.  
Tags: Startup, Information Technology, Strategy, Machine Learning

Datar, Srikant M., and Caitlin N. Bowler. "Chateau Winery (A): Unsupervised Learning." HBS Case 119-023, 2018.  
Tags: Machine Learning, Data Science, Retail, Marketing, Deliver strategic insights currently not available to business decision makers

Weiss, Mitchell, and Brittany Urick. "Testing Autonomy in Pittsburgh (A)." HBS Case 819-059, 2018.  
Tags: Government, Ethics, Policy, Healthcare, Computer Vision, Transportation

Greenstein, Shane, and Sarah Gulick. "Zebra Medical Vision." HBS Case 619-014, 2018.  
Tags: Healthcare, Image Recognition, Machine Learning, Middle East, Automation

Farronato, Chiara, Alan MacCormack, and Sarah Mehta. "Innovation at Uber: The Launch of Express POOL." HBS Case 619-003, 2018.  
Tags: Transportation, Future of Work, Machine Learning, Data Science, Startup, Information Technology, Strategy Customer Service, Change Customer Engagement

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Kerr, William R., and James Palano. "Modern Automation (A): Artificial Intelligence." HBS Case 819-084, 2018.

Tags: Data Science, Machine Learning, Adoption, Organizational Change, Ethics, Future of Work, Information Technology, Strategy, Automation, Deliver strategic insights currently not available to business decision makers

Kim, John J-H, and Shu Lin. "Liulishuo: AI English Teacher." HBS Case 319-090, 2019.

Tags: Startup, Education, Information Technology, Machine Learning, Deep Learning, Publicly Traded, Asia, Change Customer Engagement, Automation

Israeli, Ayelet, and David Lane. "DayTwo: Going to Market with Gut Microbiome." HBS Case 519-010, 2019.

Tags: Startup, Healthcare, Machine Learning, Consumer Services, Marketing, Sales, Middle East, Automate knowledge work/reduce the need for more costly human resources

## Appendix 2 Sample Convenings, 2018-2019

**Data Science Bootcamp** (April 27, 2019) – The goal of this class is to give HBS students a taste of data science. The bootcamp will define what data science is and introduce the data scientist's toolset through examples and case studies. By the end of this session, students will be able to phrase problems in data science terms, approach the solution in a structured and rigorous manner, and understand how data visualization can help convey uncovered insights.

**Fireside Chats** (April 17, 2019) – The Harvard Business School Tech Club and Laboratory for Innovation Science at Harvard will conduct two back-to-back Fireside Chats in one evening – one with startup founders and CEOs, the other with early stage VC. These Fireside Chats are informal, yet structured, conversations with Doug Levin, LISH Executive-in-Residence, as moderator, that involve business, technology and investing luminaries who will share their personal stories, industry insights and cutting-edge technology development experience.

**Future Assembly** (April 5, 2019) – Future Assembly provides a topic agnostic space for academic and practitioners to exchange ideas around new or emerging technologies. The uniting factor? A commitment to spotting the future. This session will include exploring AI-related topics.

**Applied AI** (March 2, 2019) – This one-day summit, organized by student clubs at HBS provided attendees with the opportunity to explore how machine learning is impacting the world's most important industries.

**Hype vs. Reality: The Role of Artificial Intelligence in Global Health** (February 26, 2019) – The Harvard Global Health Institute hosted an AI and Global Health Summit, the first of its kind for HGHI's community. Hype vs. Reality: The Role of Artificial Intelligence in Global Health brought together leading Harvard and MIT groups to explore the potential, promise and challenges of implementing AI-based systems to deliver healthcare in low and middle income countries (LMICs).

**SBBI Seminar: AI and the Economy** (February 25, 2019) – Jason Furman, Harvard Kennedy School, discusses his paper AI and the Economy (Paper joint with Robert Seamans), AI and the Economy and provides evidence that AI is having a large effect on the economy. Across a variety of statistics – including robotics shipments, AI startups, and patent counts – there is evidence of a large increase in AI-related activity.

**Optimal Economic Design through Deep Learning** (February 13, 2019) – David Parkes (SEAS) discussed his working paper that explores a major problem in economics, the design of an auction that maximizes expected revenue. Despite significant effort, only the single-item case is fully understood. We ask whether the tools of deep learning can be used to make progress.

**Digital Transformation Summit 2019: AI, Ethics, and Business Decisions** (February 12, 2019) – The aim of Digital Transformation Summit is simple: to help leaders gain new and informed perspective on the intersection of technology and business. This year, the focus was AI, ethics, and the implications for business decision makers.

**AI & Machine Learning Discussion and Q&A Session** (November 20, 2018) – This panel discussion and Q&A session was open to HBS students to discuss AI and machine learning. Panel participants included HBS Professors Karim Lakhani, Yael Grushka-Cockayne; moderated by Professor Christina Wing.

**The Wisdom of Human-Computer Crowds for Analyzing Medical Images** (November 21, 2018) – As part of the Doctoral Student Workshop Series Erik Duhaime, MIT Sloan School of Management

presented on how combining artificial intelligence with opinions from groups of physicians can diagnose skin cancer more accurately than either approach alone.

**Projects + Pizza** (October 23, 2018) – Projects + Pizza is a celebration of making and creating hosted by the HBS Digital Initiative, the [Rock Center](#) and [Code@HBS](#). More than a dozen student makers from across Harvard will present quick demos of a product they're building.

**Preparing U.S. Workers and Employers for an Autonomous Vehicle Future** (October 3, 2018) – Erica Groshen, Visiting Senior Scholar at the ILR School of Cornell University and Susan Helper, the Weatherhead School of Management at Case Western Reserve University discussed How the introduction and diffusion of autonomous vehicles (AVs) affect U.S. workers.

**Computers Are Becoming Less General-Purpose: Deep Learning, Hardware Specialization, and the Fragmentation of Computing** (September 5, 2018) – Professor Neil Thompson, Visiting Fellow, and Svenja Spanuth that argues that technological and economic forces are now pushing computing in the opposite direction, making computer processors less general-purpose and more specialized. This process has already begun, driven by the slowdown in Moore's Law and the algorithmic success of Deep Learning.

**What Can Machines Learn, and What Does It Mean for Occupations and the Economy?** (April 11, 2018) – Daniel Rock, PhD Student at MIT Sloan School of Management, explores which tasks will be most affected by machine learning by applying a rubric to build measures of "Suitability for Machine Learning" and apply it to 18,156 tasks in O\*NET.

**Digital Transformation Summit** (March 7, 2018) – The Digital Transformation Summit is a unique interactive experience at HBS, where you'll examine the greatest challenges and opportunities of tomorrow's technology. The Summit features eight provocative panels helmed by pioneers from both academia and practice.

**Impact of Personalized Recommendations on Consumer Choice and Product Success** (February 28, 2018) – Kartik Hosanagar, Professor of Operations, Information and Decisions at The Wharton School of the University of Pennsylvania, discussed the impact of collaborative filtering recommender algorithms (e.g., Amazon's "Customers who bought this item also bought") commonly used in e-commerce on sales diversity. We use data from a randomized field experiment run on a top retailer in North America across 82,290 SKUs and 1,138,238 users.

**Algorithmic Bias? An Empirical Study into Apparent Gender-Based Discrimination in the Display of STEM Career Ads** (October 11, 2017) – Anja Lambrecht, Associate Professor of Marketing at the London Business School discuss bias and discrimination in algorithms through the exploration of data from a field test of how an algorithm delivered a social media promotion of job opportunities in science, technology, engineering and math fields.

**Digital Transformation Summit** (April 12, 2017) – The Digital Transformation Summit is a unique interactive experience at HBS, where you'll examine the greatest challenges and opportunities of tomorrow's technology. The Summit features eight provocative panels helmed by pioneers from both academia and practice. Kathryn Hume from Fast Forward Labs discussed how companies can use machine learning within their businesses.

**Augmenting Human & Machine Intelligence with Data Visualization** (March 8, 2017) – Fernanda Viégas and Martin Wattenberg from Google presented shared their key take-aways from the talk and thoughts on the digital transformation of the economy.